CLAIMS

What is claimed is:

1. A method of training an echo canceller connected between a transmitter and a receiver in order to cancel signals transmitted by the transmitter and returned to the receiver, the method comprising the steps of:

(a) controlling sample signals output by the transmitter so that a portion of the sample signals are changed and output;

(b) transmitting an initializing signal at the transmitter; and

(c) calculating at least one coefficients and a delay time of the echo canceller based on the initializing signal returned to the receiver.

2. The method of claim 1, wherein the echo canceller is used in a digital subscriber line (xDSL) communication system.

3. The method of claim 2, wherein the initializing signal is a REVERB signal.

4. The method of claim 2, wherein the echo canceller is connected between a FIFO synchronizer of the transmitter and a time domain equalizer of the receiver.

5. The method of claim 4, wherein controlling sample signals comprises changing and outputting a portion of the sample signals output by the FIFO synchronizer.

6. The method of claim 5, wherein during the controlling step (a), one of two consecutive sample signals output by the FIFO synchronizer of the transmitter is user data and the other of the two consecutive sample signals is non-zero data.

7. The method of claim 1, wherein the step (c) comprises the steps of:

(c-1) calculating a frequency characteristic of the echo channel;

(c-2) calculating an echo response in a time domain based on the frequency characteristic of the echo channel;

(c-3) calculating energy of the echo channel based on the echo response in the time domain;

(c-4) setting a delay time of the echo canceller based on the energy of the echo channel; and

(c-5) calculating the at least one coefficient of the echo canceller based on the echo response in the time domain and the delay time of the echo canceller.

8. The method of claim 1, further comprising the steps of:

(d) transmitting a signal of a predetermined frequency at the transmitter;

(e) obtaining a first signal received at the receiver during an operation state of the echo canceller;

(f) obtaining a second signal received at the receiver during an idle state of the echo canceller;

(g) comparing the first and second received signals; and

(h) adjusting the delay time of the echo canceller according to the comparison result.

9. The method of claim 8, wherein the predetermined frequency is a pilot tone.

10. The method of claim 8, wherein in the step (h), when the first and second received signals state are different from each other, the delay time of the echo canceller is adjusted by as much as the time corresponding to phase difference of the first and second received signals.

11. The method of claim 10, wherein when phase difference between the first and second received signals is 22.5°, the delay time of the echo canceller is adjusted by as much as the time period of one sample.

12. A communication system for transmitting and receiving a data signal through a channel, the communication system comprising:

a transmitter for modifying an initializing signal and transmitting the modified initializing signal during operation in a training mode in transmitting the data signal that includes the initializing signal through the channel;

a receiver for receiving the data signal returned from the channel; and

an echo cancellation circuit connected between the transmitter and the receiver, for removing echoes of the data signal transmitted by the transmitter and received by the receiver,

wherein the echo cancellation circuit is trained in the training mode based on the initializing signal in the data signal received by the receiver.

13. The communication system of claim 12, wherein the echo cancellation circuit comprises:

a first delay unit for delaying a signal output by the transmitter;

an echo canceller for receiving a signal output by the first delay unit and removing echoes of the signal transmitted through the channel and received by the receiver; and

a second delay unit for delaying a signal output by the echo canceller and for supplying the receiver with the delayed signal.

14. A communication system for transmitting and receiving a data signal through a channel, the communication system comprising:

an encoder for encoding a data signal to be transmitted;

an inverse fast Fourier transform (IFFT) unit for converting a data signal in a frequency domain output from the encoder into a data signal in a time domain;

a transmitting FIFO buffer for synchronizing the data signal output from the IFFT unit, and modifying and outputting a portion of the data signal output from the IFFT unit;

an output filter for filtering the data signal output by the transmitting FIFO buffer and transferring the filtered data signal to the channel;

an input filter for filtering the data signal received from the channel;

a time domain equalizer for modifying the effective length of the channel in the time domain for the data signal filtered by the input filter;

a FIFO buffer for synchronizing the data signal equalized by the time domain equalizer;

a fast Fourier transform (FFT) unit for converting the data signal in the time domain output by the FIFO buffer into a data signal in the frequency domain;

a decoder for decoding the data signal in the frequency domain converted by the FFT; and

an echo cancellation circuit for removing received echoes of the data signal transmitted through the channel,

wherein the echo cancellation circuit comprises:

a first delay unit for delaying a signal output by the FIFO buffer;

an echo canceller for receiving a signal output by the first delay unit and removing received echoes of the signal transmitted through the channel; and

a second delay unit for delaying a signal output by the echo canceller and for supplying the time domain equalizer with the delayed signal.

15. The communication system of claim 14, wherein the communication system is used in digital subscriber line (xDSL) communication system.

16. The communication system of claim 14, wherein the initializing signal is a REVERB signal.

17. The communication system of claim 15, wherein, when in a normal mode, one of two consecutive sample signals output by the FIFO buffer is user data and the other of the two consecutive sample signals is zero.

18. The communication system of claim 17, wherein in a training mode, one of the two consecutive sample signals output by the FIFO buffer is user data and the other of the two

consecutive sample signals is non-zero data.

19. The communication system of claim 15, wherein the delay time of the echo cancellation circuit is calculated based on channel energy in the time domain received by the receiver.

20. The communication system of claim 19, wherein the channel energy in the time domain is calculated based on an echo response in the time domain converted from an echo response in the frequency domain by the IFFT unit of the transmitter.

21. The communication system of claim 20, wherein an echo response in the frequency domain is calculated using a ratio of a frequency characteristic received by the receiver to a frequency characteristic of the echo channel transmitted by the transmitter.

22. The communication system of claim 21, wherein the echo channel in the frequency domain that is not received among the echo channels received by the receiver is determined using extrapolation.

23. The communication system of claim 15, wherein the IFFT unit is a 128-point IFFT unit and the FFT unit is a 512-point FFT unit.

24. The communication system of claim 23, wherein the frequency characteristic of the echo channel transmitted by the transmitter is a frequency characteristic of a 512-point data

signal converted from a 128-point data signal.

25. The communication system of claim 24, wherein the delay time of the first delay unit is set to be maximum integer of delay time of the echo cancellation circuit divided by 4.

26. The communication system of claim 25, wherein the delay time of the second delay unit is represented by:

(delay time of the echo cancellation circuit) – 4 × (delay time of the first delay unit).

27. The communication system of claim 26, wherein the delay time of the echo cancellation circuit is corrected based on the delay time of a transmitting FIFO buffer of the transmitter and the delay time of a receiving FIFO buffer of the transmitter.

28. The communication system of claim 27, wherein the delay time of the echo canceller is adjusted based on the difference between a first data signal received at the receiver during operation in an operation state and a second data signal received at the receiver during operation in an idle state while the transmitter transmits a pilot tone.

29. The communication system of claim 28, wherein when phase difference between the received signal in the echo canceller's operation state and the received signal in the echo canceller's idle state is 22.5°, the delay time of the echo canceller is adjusted as much as one sample.